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LEARNING ANALYTICS IN HUMAN HISTOLOGY REVEALS DIFFERENT STUDENT' CLUSTERS AND DIFFERENT ACADEMIC PERFORMANCE

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Abstract

Universities and Higher Education institutions have created different platforms that provide digital environments with private access. These digital spaces simulate physical spaces for teaching and learning, allowing interaction between participants. The interactions are stored in the platforms so data can be analyzed to reveal behaviors and preferences. The literature shows different patterns in student's behavior and it has been demonstrated that different clusters obtain different academic performances, as well as the importance of the virtual spaces.

Human Histology is a second-year compulsory subject of the Medicine Degree at the Universidad Complutense de Madrid. It lays the foundation for Pathology learning in the third-year. Practice classes are focused on the observation of histological slides so students learn general and differential microscopic characteristics of organs. Students are expected to identify each organ under the microscope. Some years ago, teachers decided to make the evaluation a continuous process through *minitests*, short tests with projected images, and a teamwork consisting in making a notebook with freehand drawings showing the different organs and histological staining procedures. The final practice mark was obtained as the addition of the continuous activities (*minitests* 20% and teamwork 25%), the final exam (45%), and class attendance (10%).

In the virtual space created for managing Histology practices, different resources were offered such as scripts for each session, histological images file and URLs that link to histological atlas and other web sites. We present in this paper the results obtained when processing the logs of the virtual space with a free software environment for statistical computing and graphics named RStudio, an integrated development environment for R. A total of 25583 logs corresponding to the registered activity in course 2018/19 were refined and subsequently analyzed. The quantitative measures chosen were the number of total logins in the virtualized course per day, the average of the login frequency per each day of the week and per each hour of the day, the number of entries in resources per day and the number of entries in URLs per day. Also, a statistical analysis of the data was performed with SPSS 25 software, comparing the use of virtual campus to academic performance. Non-parametric Spearman correlation tests and decision trees with two cut criteria were obtained.

Results show that the activity in virtual campus is clearly conditioned by due dates (dates of *minitests* and final exam and deadline to submit the teamwork). Decision trees reveal different clusters of students according to the variables number of visits, number of entries to resources and to URLs, and that these clusters get different marks in both the *minitests* and the final exam in addition to the final mark.

Keywords: Higher Education, Learning Analytics, Histology, practical learning, clusters, academic performance.

1 INTRODUCTION

The European Higher Education Area (EHEA) puts a great emphasis on the student, compelling institutions and faculty to place students at the centre of the teaching-learning process. This shift implies not only methodological changes but also changes of mentality as it demands students to become more actively involved in their learning. Furthermore, EHEA is promoting the use of Information and

Communication Technology. The adoption of Learning Management Systems (LMS) has grown exponentially in the last decade [1-3] and has led to a wide range of learning alternatives which go beyond the traditional classroom. EHEA and LMS require more effort by the student compared with traditional learning. Students can decide what, how and when to learn, how much to learn, when to abandon and which learning strategies to adopt [2,4]. In brief, the modernization of higher education affects not only the institutions and faculty but also how students face their learning challenges.

Learning analytics is an emerging trend in the higher education field. It is an area of research related to academic and action analytics. It has become a key tool to analyse the vast amount of data that LMS store [5,6]. Moodle platform is an open source virtual learning environment (VLE). It is guided by a social constructionist pedagogy and it has become useful to adopt more active methodologies. Moodle allows the teacher to download the log files recorded through the "Reports" tool which provides information about the activity of the participants. In the last decades a good number of authors have pointed out the importance of identifying patterns of student's behavior in LMS with different purpose [7-9].

Analysis of these files can reveal different students' clusters according to their behaviour in the digital space. Measuring and making visible students' activities let teachers gain views into students' performance. Differences between successful and unsuccessful students can be useful to identify possible patterns and to inform decisions about possible problems such as risk students and dropouts, and suitable ways to address them such as adapting teaching, tutoring or tailoring assignments to the needs of the student [10]. Close monitoring of students' learning is key for a quality education as it provides the means to support students effectively [11].

Human Histology is a second-year annual subject of the Medicine Degree at the Universidad Complutense de Madrid. The methodology applied to the practical part was successfully changed some years ago [12] and a couple of descriptive papers of the students' behaviour according to their use of the virtual campus (VC) were published [13,14]. The aim of this work is to go more deeply into the analysis of the stored logs corresponding to the students' activity, trying to determine whether different patterns can be revealed and if the level of achievement could be influenced by the use of the VC that the students make of.

2 METHODOLOGY

A virtual space was created for practices of Human Histology. Educational material such as scripts for each session, histological images files, URLs which link to histological atlas and web sites was offered. Students were expected to consult it prior to practical sessions where they must make freehand drawings of histological preparations observed under the microscope.

The assessment of practical part was based on a continuous evaluation and a final exam. Continuous evaluation consisted on *Minitests* and a teamwork. *Minitests* were short tests with projected images asking the students to identify the organs, their histological features and staining techniques. They were planned at the end of 4 sessions of a total of 16. The teamwork consisted of making a notebook with histological images including the freehand drawings. Each team was made up to eight students. The final exam was stated at the end of the sessions and students have to identify organs under the microscope. The final practice mark was obtained as the addition of the continuous activities (*minitests* 20% and teamwork 25%), the final exam (45%), and class attendance (10%).

Logs of the activity on the VC in 2018/19 were obtained from Moodle. They were debugged and anonymized and subsequently the activity of students was analyzed with R, a free software environment for statistical computing and graphics and RStudio, an integrated development environment for R. The quantitative measures chosen were the number of total logins in the virtualized course per day, the average of the login frequency per each day of the week and per each hour of the day, the number of entries in resources per day and the number of entries in URLs per day. Additionally, results were compared with the average of the Moodle activity registered in the whole subjects of the Medicine degree. These data were provided by eCampus Office previously authorized by Vice-Rector of Information Technologies.

A statistical analysis of the data was performed with IBM SPSS v.25 comparing the use of VC to the academic performance. Non-parametric Spearman correlations and decision trees with two cut criteria were obtained. The criteria used were the minimisation of variance and the maximisation of analysis of variance Fisher-Snedecor test in children nodes.

3 RESULTS

In 2018/19, the group was formed by 94 students enrolled in the subject, 68.42% of which were women. Mean marks up to 10 were 6.7 ± 0.2 in minitests, 8.4 ± 0.16 in final exam, 6.5 ± 0.17 in teamwork and 7.6 ± 0.12 in final grade.

A total of 25,583 logs were stored in Moodle. The analysis shows that 100% of students visited the virtual space and consulted the resources such as files with rules for practical sessions, assessment criteria, guidelines for the teamwork, scripts and images files. URLs were consulted by 44% of students.

Data analysis revealed a clear influence of the academic calendar on the activity on the VC. In particular, the peaks of the activity were on the dates of *minitests* and final exam and the deadline to submit the teamwork. In Fig 1 grey lines represent minitests dates and teamwork due date and the red lines the final exam date.

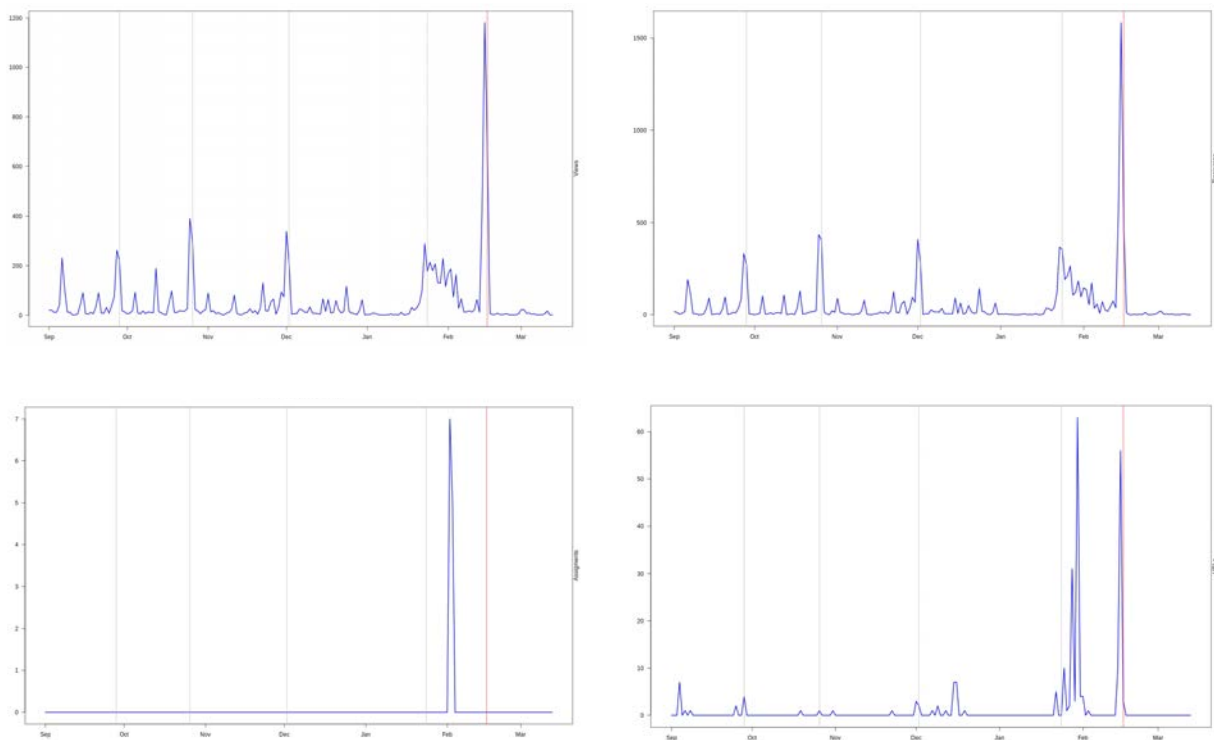
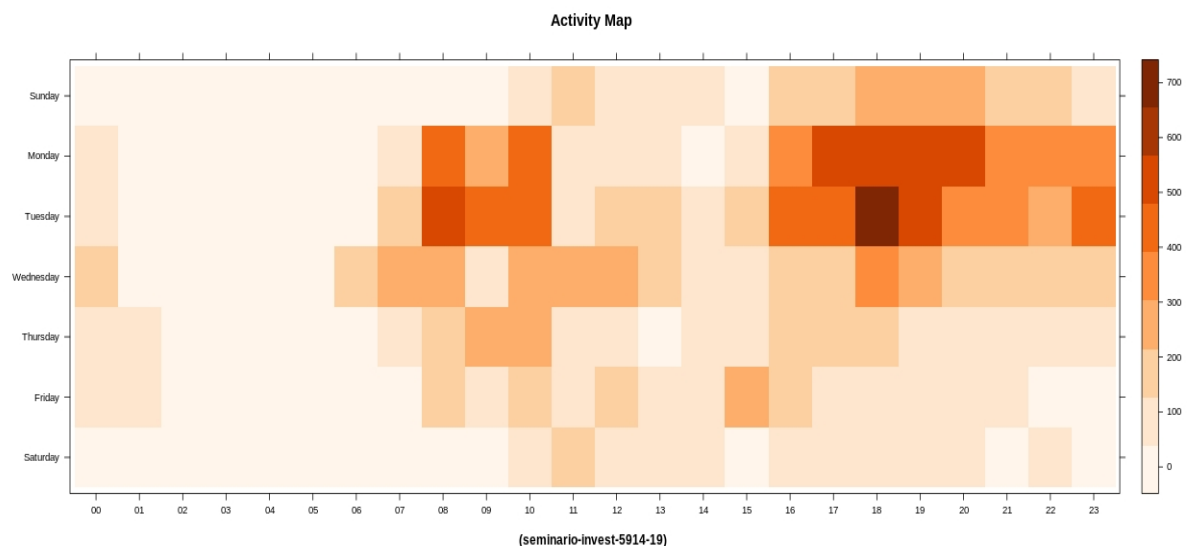


Figure 1. Activity of students on VC.

Activity on the VC varies along the days of the week and the hours of the day, as is clearly shown in Fig 2.



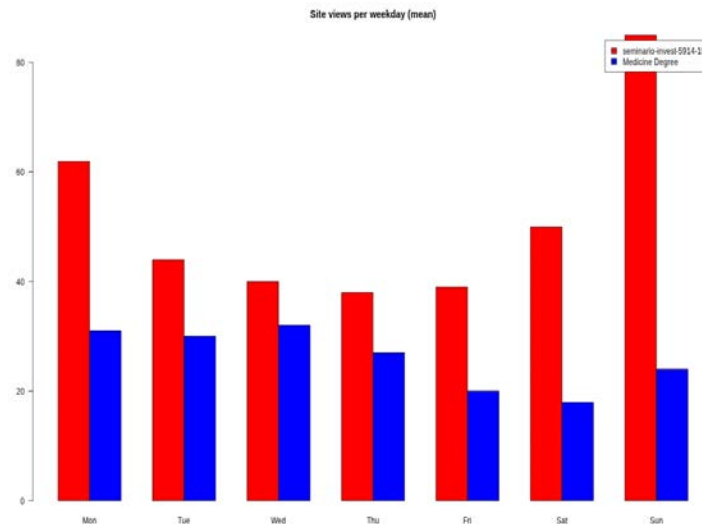


Figure 2. Activity map (up) and activity along the days of the week compared to the average of the registered activity in the whole subjects of Medicine Degree (down).

When studying the relation between student's behavior and academic performance results pointed out the existence of clusters. Fig 3 displays notable differences among students who passed with high marks (8 to 10 up to 10) or with low marks (5 to 8 up to 10) and those who failed (under 5 up to 10).

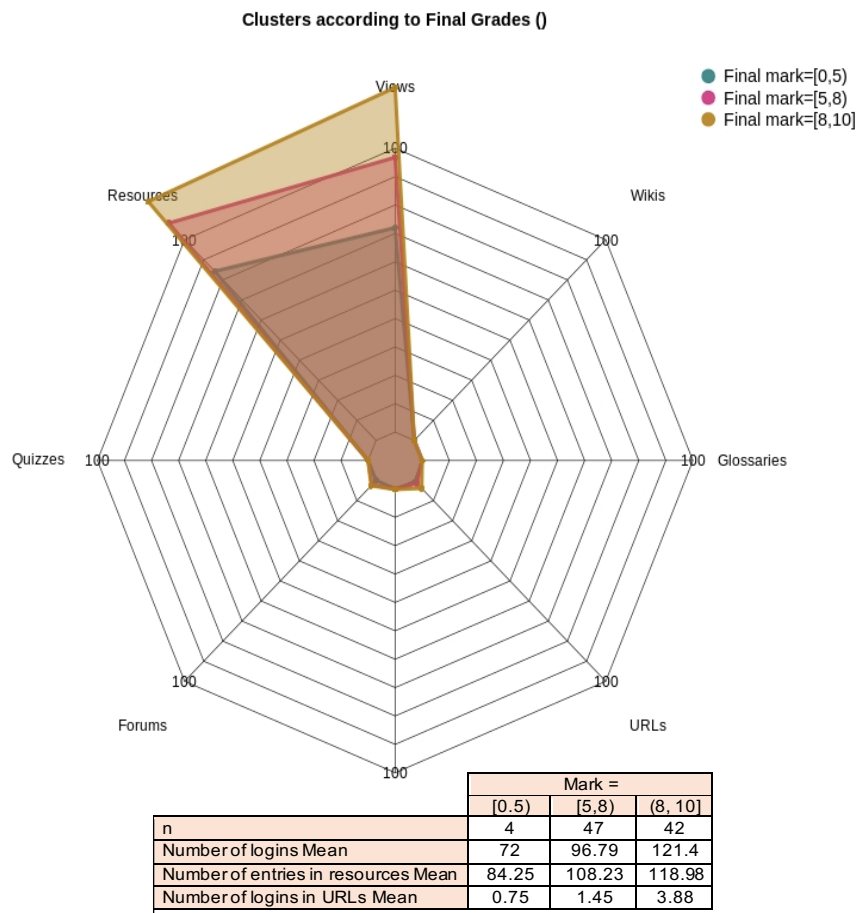


Figure 3. Behavior differences between clusters made according to final mark. Means of the number of logins, entries to resources and logins to URLs are represented for each cluster.

Statistical analysis indicated a non-parametric correlation between logins and three marks: minitests ($r=0.292$, $p=0.004$), final exam (0.236 , $p=0.023$) and final mark ($p=0.277$, $p=0.007$). Additionally, the number of entries to resources correlated to the minitests mark (0.239 , $p=0.021$) and the number of logins in URLs correlated to the final mark ($r=0.209$, $p=0.045$).

Decision trees showed the existence of students' clusters with different behavior and academic performance. Results clearly demonstrated that the more the students use the VC, the better marks they get.

Regarding continuous evaluation, the decision tree obtained for the minitest mark with the growing method CHAID pointed out that the three variables, that are logins or entries, resources and URLs, participate in making clusters, as shown in Fig 4 (left). Final exam marks were also directly related with two variables such as the number of URLs consulted and the total logins or entries, according to the decision tree obtained with the growing method CRT, as shown in the Fig 4 (right).

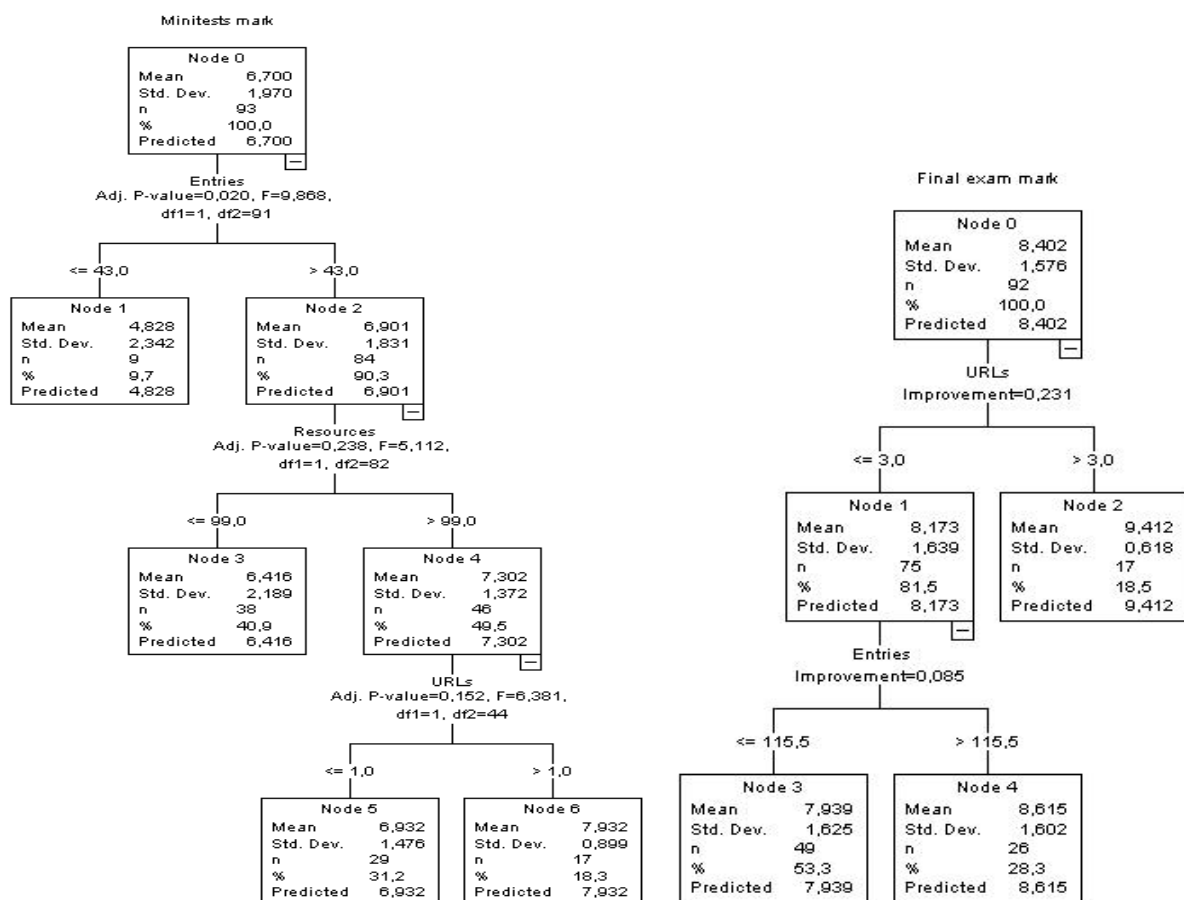


Figure 4. Left. Decision tree for minitest mark (Growing method: CHAID, estimate quality: 3.174). Right. Decision tree for final exam mark (Growing method: CRT, estimate quality: 2.142).

Finally, for the final grade, different clusters were found depending on the number of total entries and the number of URLs consulted, as show tree in Fig 5.

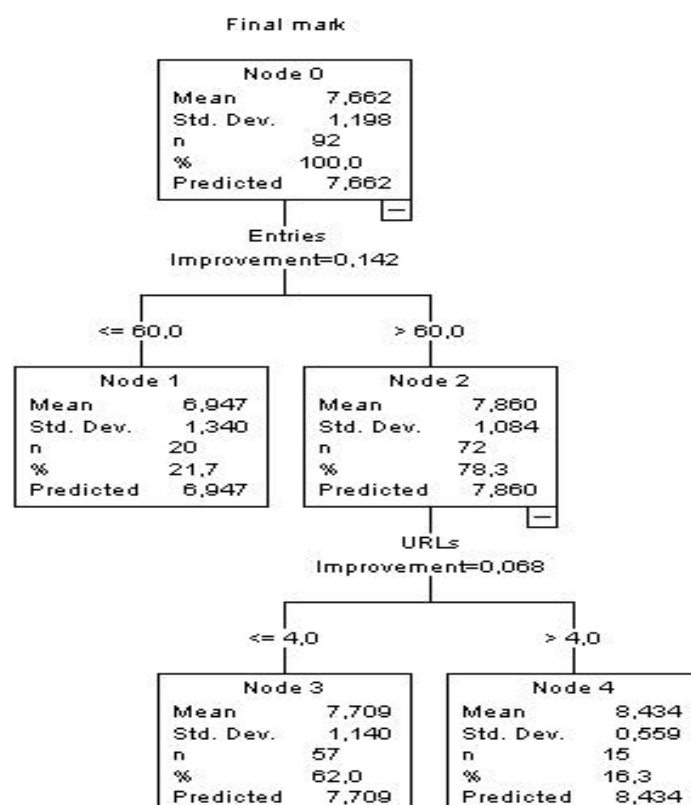


Figure 5. Decision tree for final mark (Growing method: CRT, estimate quality: 1.210).

4 CONCLUSIONS

In this paper students' practices in a blended learning environment were examined to obtain a general view of the students' actions and activities. We showed that there is a high variability in the number of actions performed by Histology students in the digital space created for practical part, finding a positive relationship between the actions performed and different marks. We tested three controllable variables for the histological practical learning and found that the three were significantly correlated with the final grade, the continuous grade and the exam grade. Our results demonstrated that the activity on the VC has a direct impact on the academic outcomes, agreeing with others authors [15-17].

Although the educational process revolves around students, teachers are still key and determinant on the student's outcomes as they assume new roles and responsibilities such as being guides, counsellors and facilitators of the student's learning. Moreover, LMS let teachers monitor learner' actions and activities. The development of digital spaces is a laborious activity for teachers. Usually, they have to choose the contents, to create resources, to design activities and to determine the most suitable elements and structure of the course [18,19].

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